

	<b>OBJET (Subject):</b>	<b>Ref : SEDI-GLAST-N5320-176-PA</b>
	<b>DPD IRRADIATION TEST</b>	<b>GLAST LAT Doc No.</b>
		<b>LAT-TD-00787-01</b>
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		<b>Annexes :</b>
		<b>Date : 10/06/02</b>

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**Change History log**

1

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## 1 Introduction

### 1.1 Purpose

For the moment the requirement for the radiation hardness of the DPD is 10kRad (for 10 years working) with a degradation of their performances less than 10%. Hamamatsu have performed test on similar PIN Photodiodes (S3590-08 100mm<sup>2</sup> in ceramic carrier with same epoxy resin window). Their tests show no degradation up to 10kRad. Our DPDs are similar but one main difference is the size of the PIN diode (152 and 25mm<sup>2</sup>). We have done irradiations with Co60 radioactive source on two DPDs.

We have check three parameters:

- The Dark Current at 70V bias Voltage,
- The Capacitance at 70V bias Voltage and 1MHz,
- The sensitivity at 525nm and 660nm.

Then we have annealed the DPDs 24hours at 80°C.

### 1.2 Definition

#### 1.2.1 Acronyms

GLAST	Gamma-Ray Large Area Telescope
LAT	Validation Module #2 (12 Amcrys Xtals)
DPD	Dual PIN photoDiode
L.Y.	Light Yield Mean centered value of Right and Left PIN
Tap Saclay	Tapering in % slope on the total length of the crystal
Tap Sweden	Tapering in % Ratio of the L.Y. at 3cm of both ends

#### 1.2.2 Definitions

$\gamma$	Gamma Ray
$\mu\text{sec}, \mu\text{s}$	microsecond, $10^{-6}$ second
nm	nanometer
$\mu\text{m}$	micrometer
mm	millimeter
cm	centimeter
eV	Electron Volt
MeV	Million electron Volt, $10^6$ eV
e/MeV	electron by MeV deposit in Xtal
ph	photons



DPD IRRADIATION TEST

CEA



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DSM-DAPNA

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2 Hamamatsu Results

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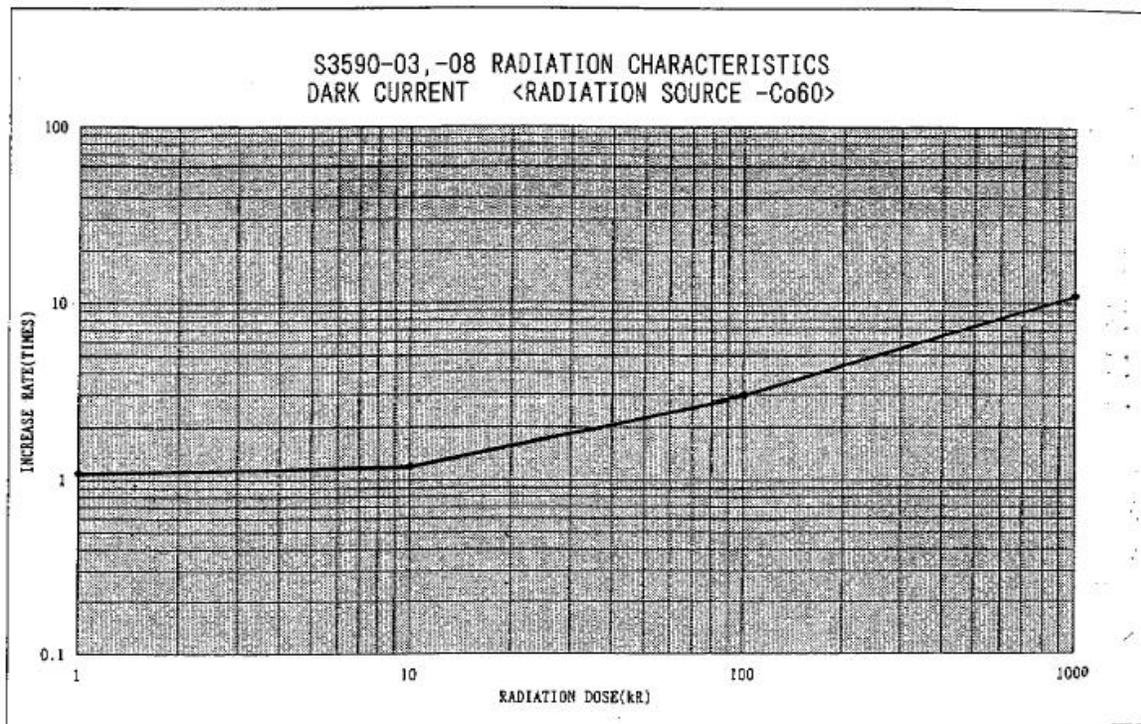
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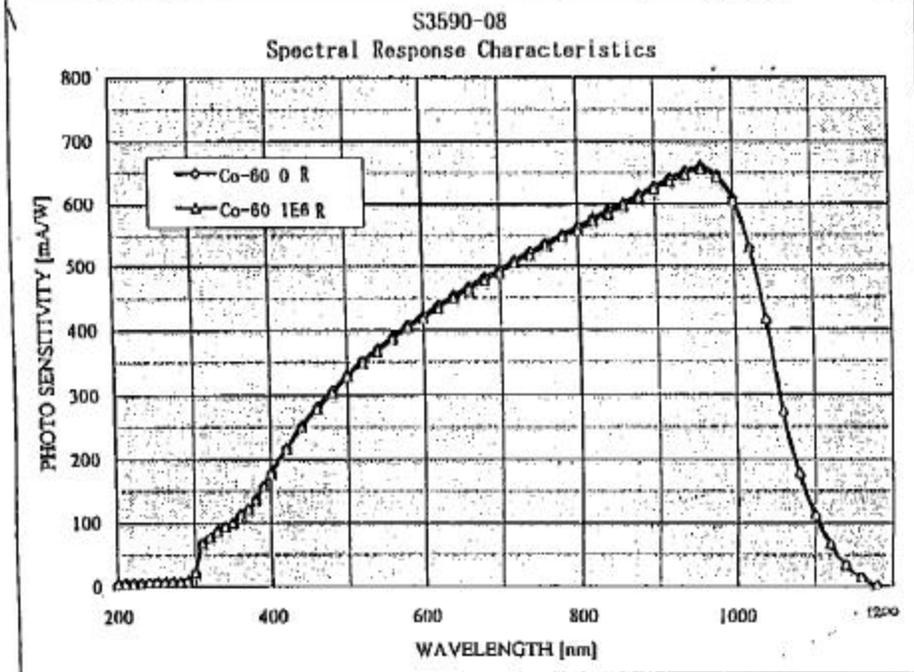
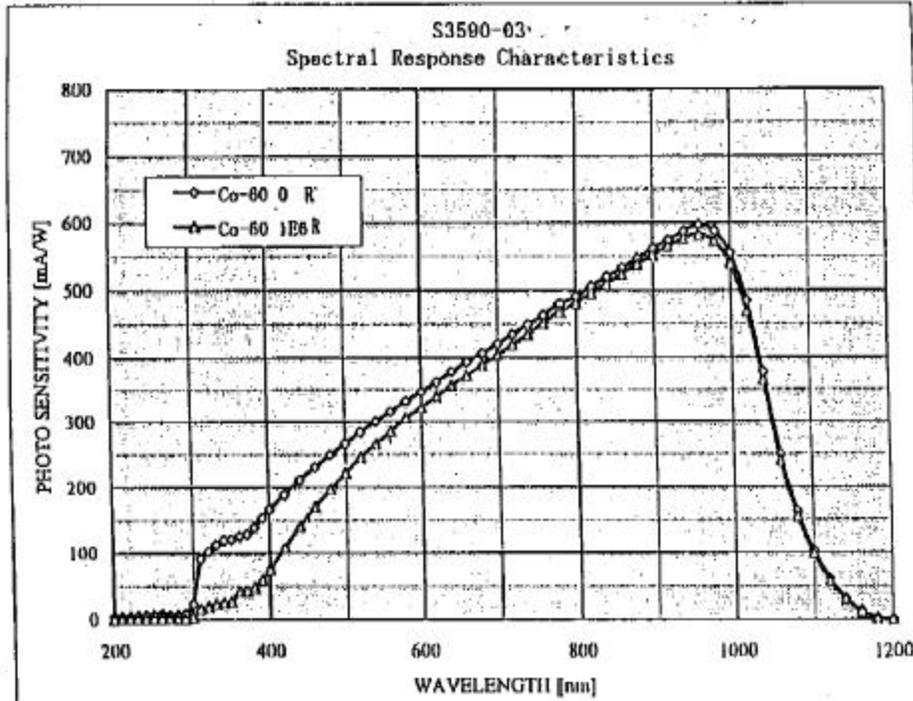
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### 3 Irradiation

We have done 4 irradiations summarized in the Table 1. Note they were done with no polarization of the DPDs.

#	Date	Flux (Rad/h)	Dose (kRad)	Total Dose (kRad)
1	8-13 March	9.2	1.1	1.1
2	19-25 March	37	5	6.1
3	25 March-4 April	37	8.6	14.7
4	15-21 May	66	9	23.7

Table 1 : Irradiation progress

### 4 Measurements

The Table 2 (absolute value) and 3 (relative value) summarized the results obtained on the 2 DPD # 91 and 102.

Dose (kRad)	DPD # 91							
	ID(A) (nA)	ID(B) (nA)	Ct(A) (pA)	Ct(B) (pA)	S(A) 525nm (A.U.)	S(A) 660nm (A.U.)	S(B) 525nm (A.U.)	S(B) 660nm (A.U.)
0	0,46	<b>1,28</b>	15,63	63,64	214	841	1272	963
1,1	0,55	1,47	15,71	63,83	209	814	1236	925
6,1	1,14	2,59	15,66	63,82	210	808	1302	951
14,7	2,50	5,30	15,45	63,41	208	837	1239	938
23,7	3,86	<b>8,21</b>	15,46	63,55	196	835	1185	948
Dose (kRad)	DPD # 102							
0	0,43	<b>2,24</b>	15,56	63,91	212	831	1232	939
1,1	0,53	2,42	15,64	64,07	215	826	1259	936
6,1	1,16	3,52	15,60	64,08	213	822	1233	925
14,7	1,87	4,97	15,38	63,64	210	840	1215	920
23,7	3,61	<b>8,55</b>	15,40	63,73	196	835	1148	930

Table 2 : Absolute value results

Dose (kRad)	DPD # 91							
	ID(A)	ID(B)	Ct(A)	Ct(B)	S(A) 525nm	S(A) 660nm	S(B) 525nm	S(B) 660nm
0	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
1,1	1,19	1,14	1,00	1,00	0,98	0,97	0,97	0,96
6,1	2,49	2,02	1,00	1,00	0,98	0,96	1,02	0,99
14,7	5,43	4,14	0,99	1,00	0,97	0,99	0,97	0,97
23,7	8,39	6,41	0,99	1,00	0,92	0,99	0,93	0,98
Dose (kRad)	DPD # 102							
0	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
1,1	1,24	1,08	1,00	1,00	1,01	0,99	1,02	1,00
6,1	2,71	1,57	1,00	1,00	1,00	0,99	1,00	0,99
14,7	4,35	2,22	0,99	1,00	0,99	1,01	0,99	0,98
23,7	8,40	3,82	0,99	1,00	0,92	1,00	0,93	0,99

Table 3 : Relative value results

The tables show:

- no impact of the irradiation on the capacitance,
- A very small effect on the green sensitivity (see Fig. 2).
- A great effect of the radiation on the Dark Current (see Fig. 1),
- The D.C. of the PIN A of both DPD was initially identical so the blue curves of figure 1 are very similar (relative value),
- Unlike the D.C. of the PIN B of the 2 DPDs was initially very different (a factor 2) and over 15kRad it become the same, so the green curves of figure 1 are different (relative value),

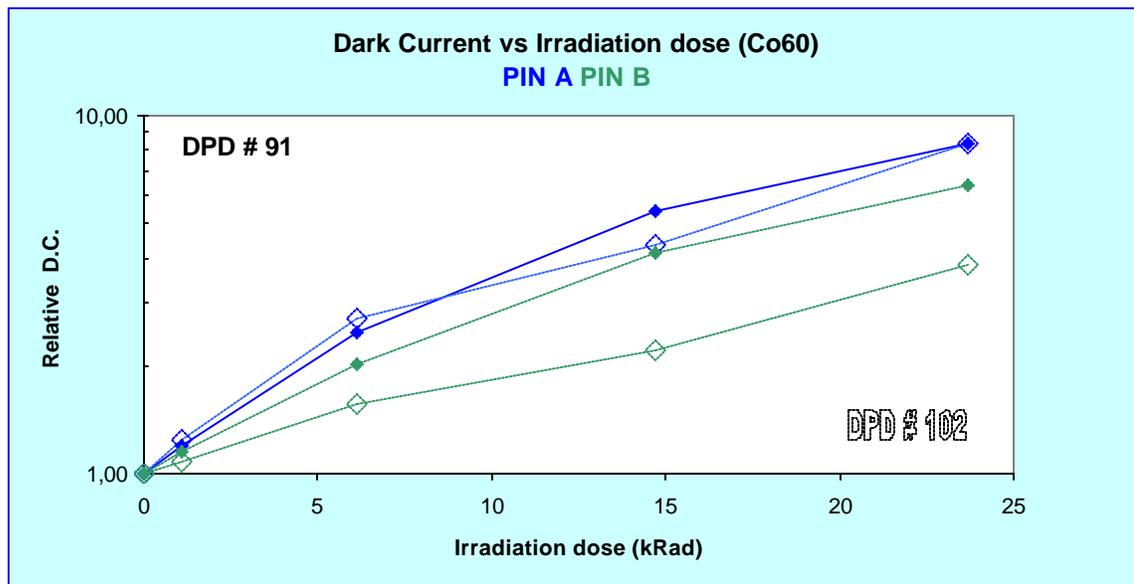


Figure 1: Effect of Radiation on Dark Current (Relative value)

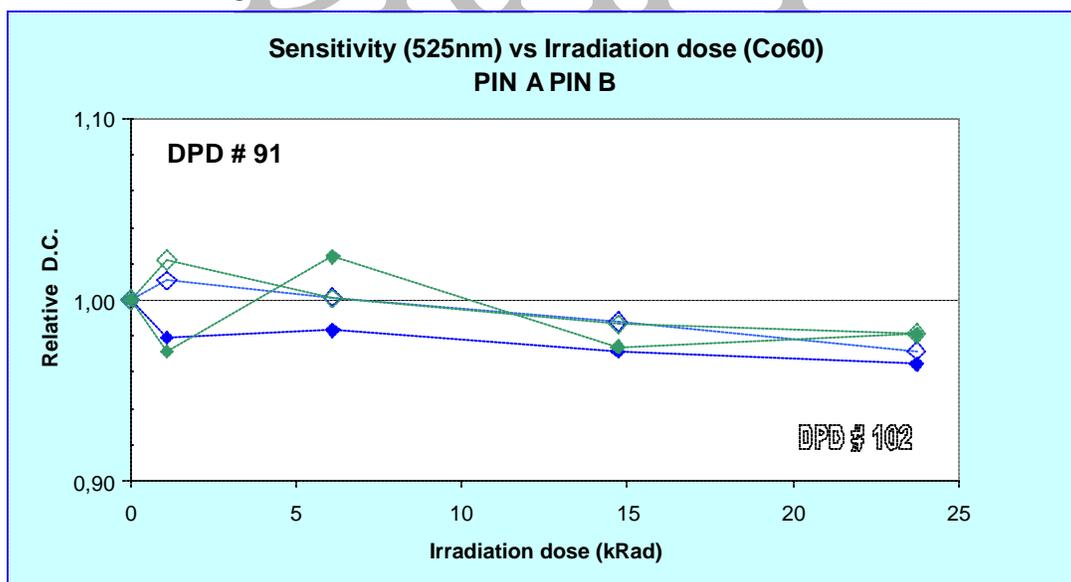


Figure 2: Effect of Radiation on Green Sensitivity (Relative value)

## 5 Annealing

We have then annealed the 2 DPDs 24 hours at 80°C. The measurements show no difference for the capacitance and the sensitivity and a same little recover of the D.C. for each DPD of 7% and 12% respectively for PIN A and B.

## 6 Conclusions

The incidence of the radiation on DPD is essentially on the Dark Current as for Hamamatsu. But the level of this incidence is more important in our case for the DPD (S8576). The D.C. at 10kRad is increased by about a factor 1.1 and 3 respectively in Hamamatsu's measurement (PD S3590-08) and in Saclay's one (DPD S8576).

DPD with different initial D.C. reach the same one after radiation exposure of about 15kRad.

Annealing of irradiated DPD do not enhance significantly its degradation.

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